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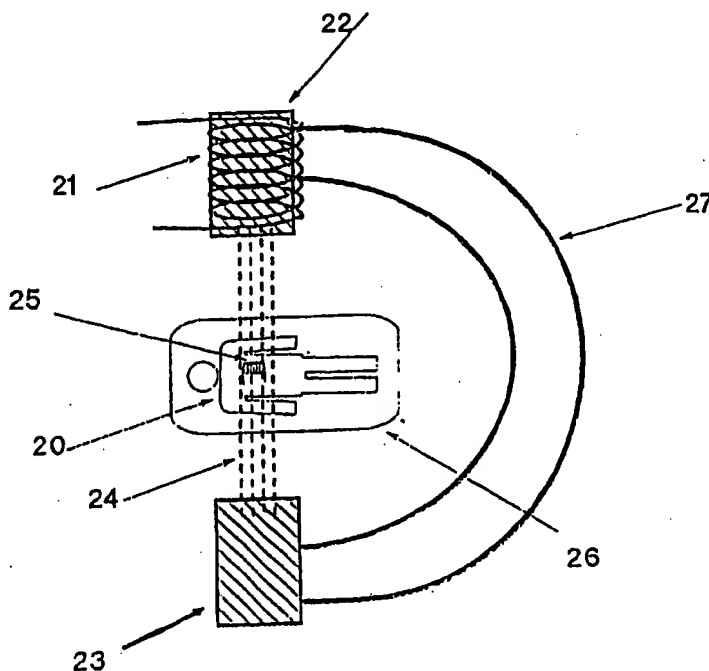
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(54) Title: METHOD FOR THE TRANSFER OF ENERGY TO AN ELECTRONIC CIRCUIT IMPLANTED IN A LIVING BODY AND A DEVICE FOR SUCH METHOD

(57) Abstract

The present invention relates to a method for the supply of energy for operating an electronic circuit which is implanted in a living body comprising: a) implanting an electronic circuit in a living body, wherein a coil and rectifying system are part of the circuit and they are connected to a supply current to the electronic circuit; b) positioning the body containing the implant between the two poles of an external magnet; c) inducing an AC current flow in the external magnet for the period of time required to operate the internal electronic circuit; d) passing a magnetic flux through the coil in the body. The present invention also relates to a device comprising an external coil (11) wound on a magnet whose poles (12, 13) face each other and the body (10) in which the internal circuit is implanted is positioned in between them so that the magnetic flux passes through the body.



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**METHOD FOR THE TRANSFER OF ENERGY TO AN ELECTRONIC CIRCUIT
IMPLANTED IN A LIVING BODY AND A
DEVICE FOR SUCH METHOD**

FIELD OF THE INVENTION

The present invention relates to a power supply for supplying energy to an implanted medical device, without physical connection between such power supply and implant.

Thus, the novel system enables the supply of power to an implant in a non-invasive manner.

The power can be supplied directly so as to operate the implant or it may be used to charge a secondary battery which is part of the implant.

The invention also relates to a method for supplying from an external unconnected device, power to an implant inside the body, which is generally a human body. Such method enables operation of the system either by the supply of power in a direct manner or by supplying electric power for charging a secondary cell, part of the implant.

The invention relates to a method for the transfer of energy to an electronic system implanted in a living body, for the purpose of operating such system or for the purpose of charging a battery in such system, by external means without a direct connection, such as conductors, with the circuit implanted in the body.

Various systems are implanted in living bodies, generally human bodies. When the system is electronic, supposed to perform activities or to transfer data, the problem arises of how to supply energy for the operation of the system.

Electronic systems are usually implanted so that there is also enough room for a battery but the problem of the life of the battery exists.

The present invention enables the charging of such a battery within the body by external means enabling operation, for a required time, of the system implanted in a place where there is no room for a battery.

The present invention relates to a method for supplying electric energy to an electronic circuit implanted in a living body and a device for use in such method. In the method of supply of energy an internal circuit and an external electronic device are used. The internal circuit, which is connected to the energy consumer, comprises an electric coil and a current rectifying system, and the external device composes an electric coil which is mounted on a large magnet or electromagnet and between the two poles of the large magnet or electromagnet, the magnet or electromagnet is of an annular type whose poles are directly opposite to each other. A strong alternating current is made to flow in the external coil, creating a strong magnetic flux, the magnet or electromagnet thereby causing the lines of the flux to be transferred through it and in straight lines between the magnet poles.

The body in which the internal circuit is implanted is positioned between the poles of the magnet or electromagnet so that the coil which is part of the internal circuit will be in the center of the lines of the flux created by the alternating flow in the external coil and which pass through the straight lines between the poles of the magnet or electromagnet and parallel to them, the lines of the flux pass through the internal coil and produce an alternating current in its windings, which is rectified by way of a rectifier circuit and supplied directly to the electronic circuit or used for charging the battery of the internal electronic circuit.

The voltage produced in the internal coil depends on a number of factors, such as the number of windings of the coils, the radius of the coil, the magnetic flux created in the internal coil by the external coil in relation to the mutual angular orientation of the two coils, on the current in the external coil and on the rate of change of the current in the external coil. The magnetic screen of the body in which the coil is implanted is negligible.

The invention also comprises a device for use in this method comprising a large annular magnet or electromagnet, around which wire coil is wound. The body in which the energy consuming circuit is implanted rests on a bed between the magnetic poles. Both the magnet or electromagnet, and the bed have numerous motional degrees of freedom so that it is possible to bring the body to the best possible position between the coils according to the location of the implanted circuit.

Stages of the method are as follows:

- a. When the circuit is implanted in the living body, an electric coil and a rectifying system are included in the circuit as a power supply to the electronic circuit or as circuit for charging the battery, if such a circuit exists.
- b. For the purpose of operating the internal electronic circuit or charging the battery, the live body is positioned between two poles of an annular magnet or electromagnet around which the wire coil is wound so that the electronic circuit with the battery and the rectifying system will be aligned with the lines of the flux between the magnetic poles.

- c. Alternating current flows through the coil wound on the external magnet or electromagnet during the time required for operating the internal electronic circuit or for charging the battery. This current will cause the magnetic flux to be transferred by way of the coil installed in the body.
- d. The magnetic flux which is transferred by way of the coil installed in the body produces an alternating current which is rectified by the rectifying circuit coupled to the coil so that a direct voltage is received which supplies current to the circuit and/or the battery.

The invention is described with reference to schematical Figures 1 and 2. The figures are for the purposes of description only and are not intended in any way to limit the scope of the invention.

Figure 1 shows how energy is transferred to the circuit implanted in the body.

Figure 2 illustrates a device for transferring energy.

As shown in Figure 1 an external coil (11) is wound on an annular magnet or electromagnet whose poles (12, 13) face each other. The flow of an alternating current in the coil (11) produces lines of flux (14) which flow in straight lines from one pole to the other due to the presence of the magnet or electromagnet. The body (10) in which the internal circuit is implanted is positioned so that the internal coil (15) which is implanted in the body will reach a position so that the lines of flux will be transferred through it. An alternating current is created on the internal coil (15) and this tension is rectified by the diode circuit (16) and received (17) and supplied directly to the electronic circuit or the battery of the electronic circuit.

Figure 2 illustrates a device used in the transfer of energy to the circuit implanted in the body. An electric coil (21) is wound on a large, annular magnet or electromagnet whose poles (22, 23) face each other. The lines of direct flux (24) are created by the flow of alternating current in the coil and transferred through the magnet or electromagnet and between the poles. There is provided a bed (26) on which the body rests (20) containing the internal circuit (25). The bed and the magnet or electromagnet can be moved in such directions and to various angles so that it is possible to bring the internal circuit to the optimum position within the lines of flux. The voltage created in the coil within the internal circuit, is rectified and supplied to the energy consumer.

By means of this method and the device, it is possible to operate an electronic circuit for a required time, for the purpose of supplying measurement data. In circuits which operate in a continuous manner and which run on batteries, it is possible to renew the battery charge, when it is weak, by means of the method and the device in the present invention.

CLAIMS

1. Method for the supply of energy for operating an electronic circuit which is implanted in a living body, comprising:
 - a. Implanting an electronic circuit in a living body, where a coil and an rectifying system are part of the circuit which are connected to a supply current to the electronic circuit;
 - b. Positioning the body containing the implant between the two poles of an external annular magnet or electromagnet on which is wound a wire-coil so that the internal electronic circuit with the coil and the rectifying system are coupled with the lines of flux established between the magnet or electromagnetic poles;
 - c. Pressing a current through the coil wound on the external magnet or electromagnet to induce an AC current flow for the period time required to operate the internal electronic circuit, which current causes the magnetic flux to be transferred through the coil in the body;
 - d. Passing a magnetic flux through the coil in the body so as to produce an alternating current in the coil which is rectified by the circuit coupled to the coil and a rectified current is received which operates the internal electronic circuit.
2. Method for the supply of energy as claimed in Claim 1, wherein the generated energy is used for charging a battery implanted in the living body.

3. A device for use in the supply of energy as claimed in Claims 1 or 2 comprising an annular magnet or electromagnet whose poles face each other, a coil wound around the magnet or electromagnet for the flow of an alternating current through it and the production of a magnetic flux in the magnet or electromagnet and a body located between the poles of the magnet or electromagnet so that the magnetic flux passes through the body.
4. A device as claimed in Claim 3, wherein the magnet or electromagnet have motional degrees of freedom so as to align the body to an optimum position in relation to the magnetic flux.

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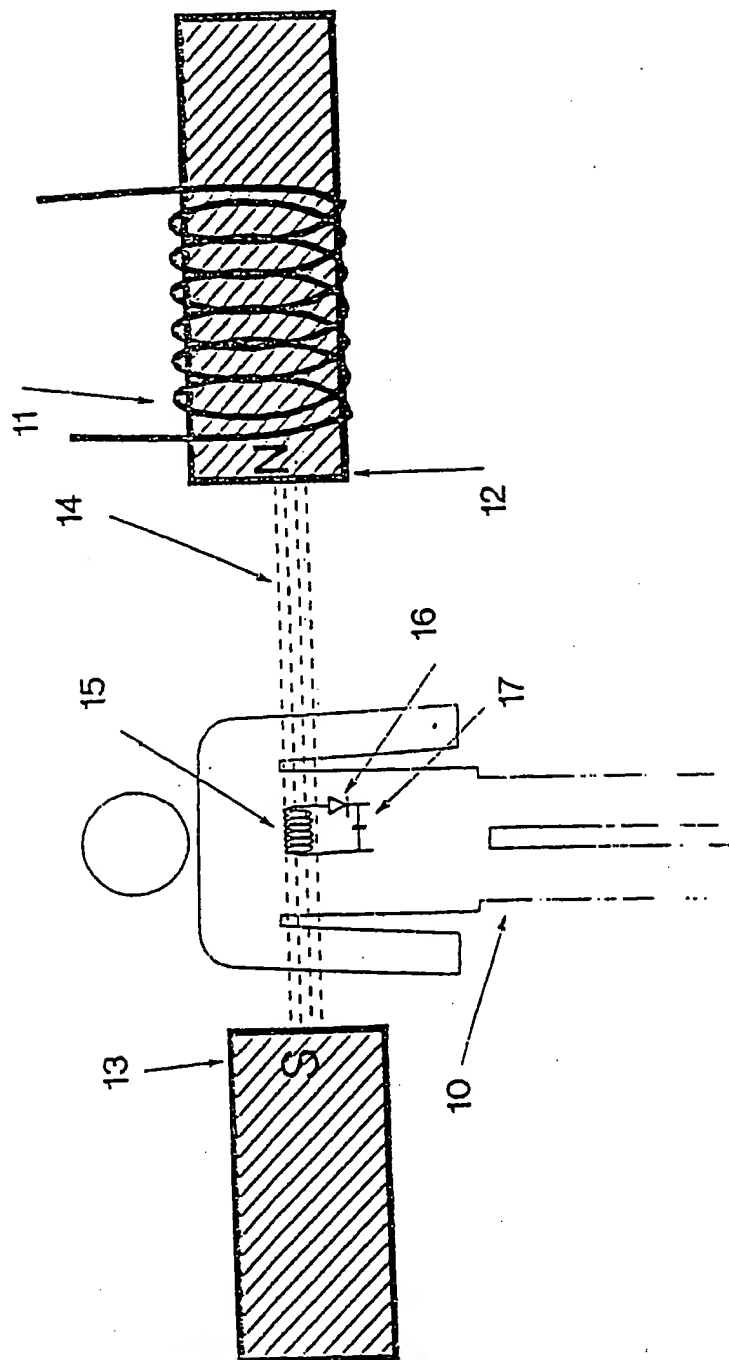


FIGURE 1

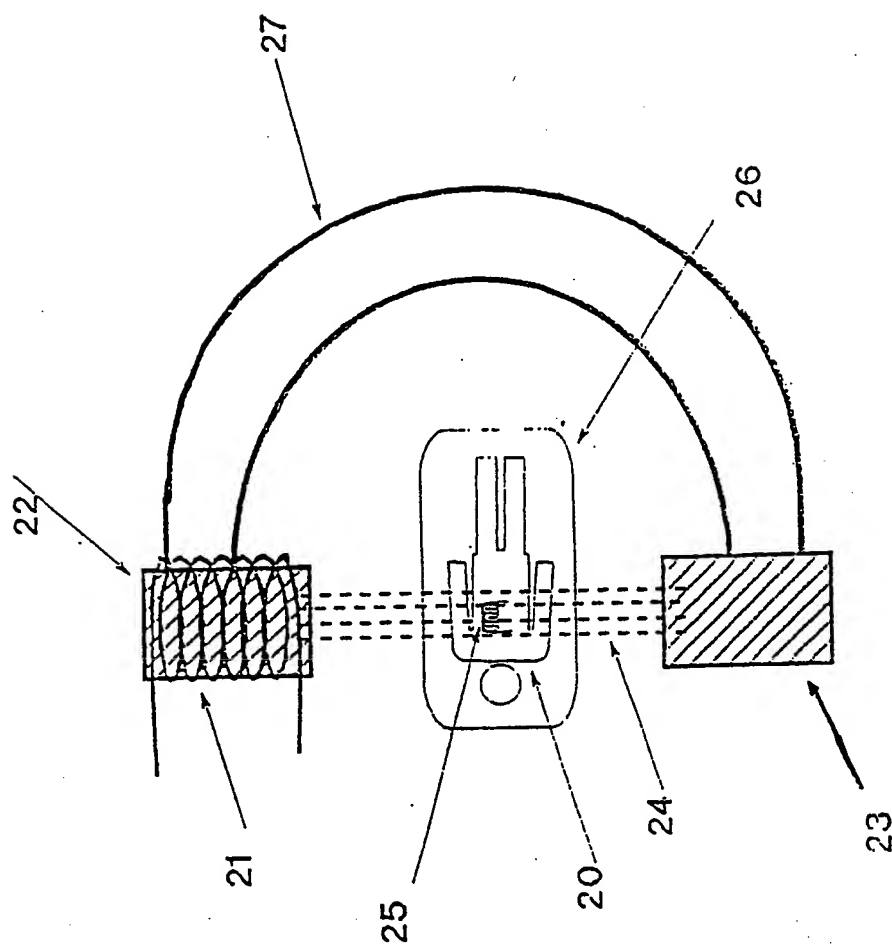


FIGURE 2

INTERNATIONAL SEARCH REPORT

Int. l. Application No

PCT/IL 98/00127

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 H02J7/02 H02J5/00

According to International Patent Classification (IPC) or to both national classification and IPC

8. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 6 H02J A61F H01F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 4 719 919 A (MORAN CHRISTOPHER ET AL) 19 January 1988 see abstract; figure 2A ---	1-4
A	EP 0 499 939 A (IMPLEX GMBH) 26 August 1992 see column 5, line 3 - line 31; figure 4 ---	1-4
A	PATENT ABSTRACTS OF JAPAN vol. 013, no. 525 (E-850), 22 November 1989 & JP 01 214230 A (NEC CORP), 28 August 1989, see abstract -----	1-4



Further documents are listed in the continuation of box C.



Patent family members are listed in annex.

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Date of the actual completion of the international search

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INTERNATIONAL SEARCH REPORT

Information on patent family members

Int. Jonal Application No

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